SPERRY MICROWAVE ELECTRONICS COMPANY
DIVISION OF SPERRY RAND CORPORATION

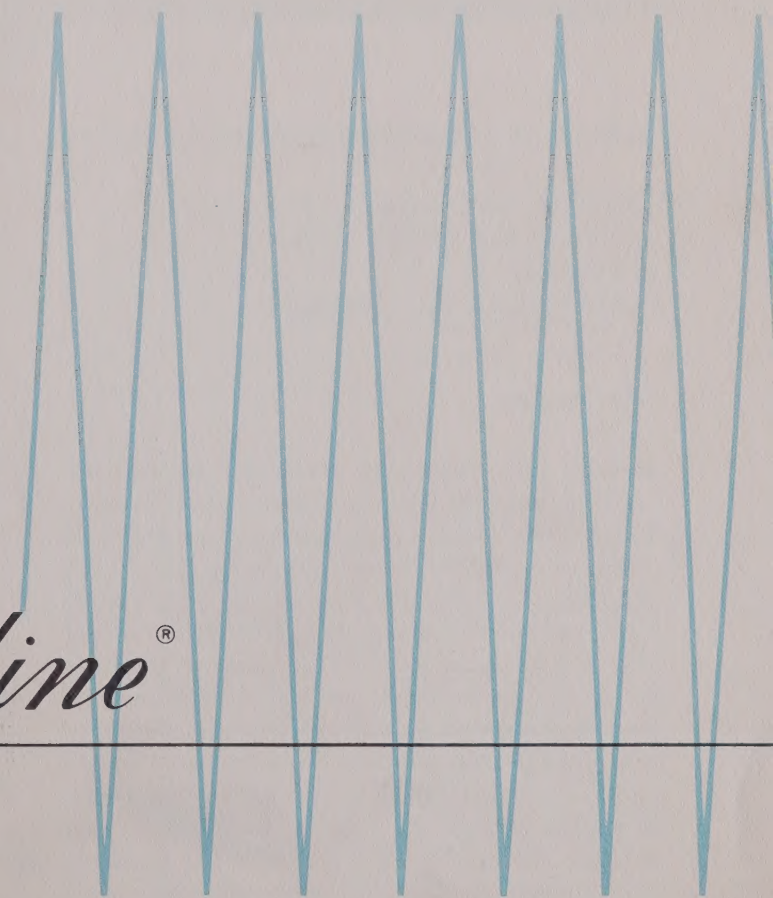
SPERRY

MICROLINE
CAVITY FREQUENCY METER
MODEL 14C1
SERIAL 13

X-80

1,000$

PRECISION
FREQUENCY METERS



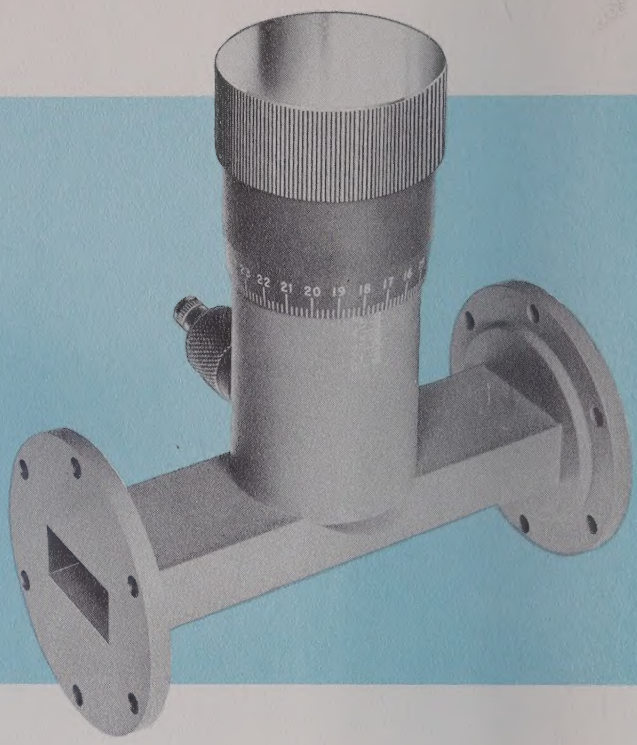
SPERRY *Microline*®

PERRY MICROWAVE ELECTRONICS COMPANY
VISION OF SPERRY RAND CORPORATION • CLEARWATER, FLORIDA

SJ-26-0034

14S1
14C1
14G1
14X1

PRECISION FREQUENCY METERS



- **Transmission and absorption types of indication**
- **Temperature and humidity curves**
- **.01% accuracy**
- **Reduces necessary Test equipment**

APPLICATIONS

Microline cavity frequency meters are intended primarily for precision laboratory measurements and production tests where a high degree of accuracy and resolution is required. These units can be used as both transmission and reaction type meters. Ordinarily, in high Q cavities the resonant dip is difficult to locate and often it is necessary to locate the unknown frequency by use of a low Q search type meter. However, since these Microline meters are also of the transmission type, they give a positive indication of resonance. When the cavity is resonated to the frequency of the signal, energy is coupled through the cavity to an integral crystal detector. For c-w signals a d-c millimeter having an input impedance of approximately 250 ohms can be connected to the BNC jack. If the signal is modulated, the Microline 29A1 SWR Indicator can be used in place of the milliameter. Because of their design, use of ternal couplers and detector mounts is unnecessary addition to the obvious dollar savings involved, re ings are made more accurate and reliable by elim tion of other components.

DESCRIPTION

The resonant cavity in each instrument is fabrica by a precision process that assures minute toleran stress-free metal, and a true cylindrical shape.

The cavity is tuned by means of a plunger with folded half-wave traps which provide an excellent s circuit over the operating frequency range of e instrument. This design eliminates the use of con fingers or sliding contacts which may become unr ble with use. The tuning plunger is actuated by a screw drive and position is accurately indicated l referenced micrometer scale.

In Models 14C1, 14G1, and 14X1 the cavity is rig joined to the broad surface at the mid-point of a s length of rectangular waveguide. Input signals ma introduced at either end of the guide. A fractio the microwave power is fed into the resonant ca

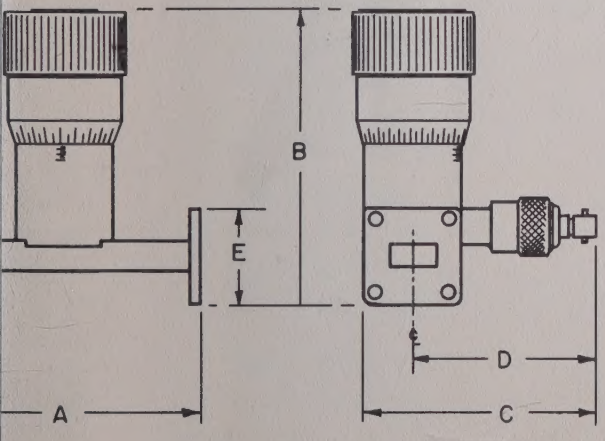
SPECIFICATIONS

MODEL	Frequency kmc	Absolute Accuracy	Approximate Loaded Q	Absorption Dip Produced in Matched Line	Price
14S1	2.575 - 3.780	1/10,000	10,000	5%	$850
14C1	4.01 - 6.00	1/10,000	7,000	5%	$565
14G1	5.49 - 8.10	1/10,000	7,000	3%	$450
14X1	8.10 - 11.90	1/10,000	5,000	5%	$450

rough a coupling iris in the common wall at the junc-on surface. The Model 14S1 has a type N input to the vity.

In order to provide a transmission resonance indica-on, all models are provided with an output arm which ouples a portion of the r-f energy from the cavity rough a lN23 type crystal rectifier. The center con-uctor of the removable output connector is fitted with crystal retainer and a disk-type bypass capacitor which prevents r-f leakage into the d-c line. The connector is terminated with a BNC jack.

Each instrument is furnished with a crystal rectifier and is calibrated at the factory with this crystal installed. Complete calibration data is furnished with each meter . . . a standard calibration table, universal-correction chart, frequency-correction curve for the individual instrument and a humidity-temperature resonator correction nomograph.



Model	A	B	C	D	E	Weight (lbs.-oz.)
14S1	8¾	12¾	8⅛	7¾	*	17- 8
14C1	6½	9⅛	5½	3¾	3⅝	7- 4
14G1	6⅛	6¾	5	3½	3⅛	4-14
14X1	4⅝	5⅜	4⅛	3⅜	1⅝	2- 0

* Coaxial Input

SPERRY Microline®

OPERATING AND MAINTENANCE INSTRUCTIONS

Since these instruments are designed to provide precision frequency measurements, certain precautions should be observed in their operation. As mentioned previously, all of the cavities except that of Model 14S1 are mounted on short lengths of waveguide but the electromagnetic coupling between the cavities and the waveguide is loose. This permits direct connection to a transmission line with little or no effect on the line except when resonance is approached. In all cases, however, it is advisable to keep the transmission line well matched. The Model 14S1 may be connected to a transmission line by means of a directional coupler or suitable adapters and a 50-ohm cable.

Both reactive and transmission resonance indications may be obtained with these frequency meters in the following manner:

1. To obtain a reactive indication, some means must be provided for monitoring the r-f power in the main line. A crystal detecting section, bolometer mount or mixer terminating the line as an r-f head may be used for this purpose. Resonance will be indicated by a pronounced dip in the detector fed by the r-f head.
2. If a transmisison indication is desired, an output indicator having an input impedance of approximately 250 ohms should be connected to the output arm of the cavity. Resonance is indicated by a peak reading of the output indicator. Tune the cavity slowly until a maximum resonance indication is obtained.

Each instrument is furnished with complete calibration data. These include a universal temperature-correction chart, frequency curve for the individual instrument, and a humidity-temperature resonator correction nomograph.

In order to secure maximum accuracy from these cavity frequency meters, it is necessary to apply all the corrections as indicated. However, close approximations to actual frequency can be obtained by the use of the individual frequency curve only. In the measurement of frequency differences good accuracy will result from consideration of the particular calibration curve alone, since the other corrections applied to the two frequencies will not significantly affect the difference between them.

These instruments are designed for minimum servicing. The mechanical construction provides a minimum of sliding surfaces, thereby reducing wear. All cavity frequency meters are fully adjusted and accurately calibrated at the factory and no maintenance should be performed by the customer. If the rectifier crystal is replaced, the frequency meter should be recalibrated to maintain maximum accuracy.

1. Determination of the Frequency Corresponding to an Observed Dial Setting.

a. Ambient Temperature Correction - Note the dial setting (D) of the Frequency Meter at resonance. Refer to the applicable Universal Temperature Correction Chart in which the correction (K) is plotted as a function of ambient temperature for various values of D. For values of D not plotted on the chart, obtain the value of K by interpolating either arithmetically or visually, making some allowance for the fact that K is not linear in D, but cubic. Add the value of K algebraically to the initial dial reading to obtain the corrected dial reading (R'):

$$R' = D + K$$

b. Correction for Deviation from Standard Calibration - Refer to the Correction Curve for the particular instrument. The observed dial reading lies along the X axis. Obtain the correction (d) from the Correction Curve using the actual or observed dial reading. Add the correction (d) algebraically to the dial setting, or, if the correction is to be applied to the answer obtained in step a, add the correction algebraically to that answer to obtain a corrected dial reading (R), combining both corrections:

$$R = R' + d$$

c. Interpolation - If the value for R found in step b does not appear in Column 1 of the Standard Calibration Table, obtain the interpolated frequency (f_{int}) from the table by two computations. Column 1 of the table gives the dial setting in increments which correspond to linear variations of frequency. Column 2 gives the frequency corresponding to the values of dial setting in Column 1. Column 3 gives the tabular frequency difference (ΔF) between two successive values in Column 2. Make the computations as follows:

$$(1) \quad \Delta f = \frac{\Delta F}{\Delta D} (D_G - R)$$

where

Δf = interpolated frequency increment

ΔF = frequency difference (Col. 3) between the tabulated values (Col. 2) corresponding to the nearest pair of tabulated dial settings (Col. 1) *above* and *below* the corrected reading (R)

D = difference between the nearest pair of tabulated dial settings (Col. 1) *above* and *below* (R)

R = dial setting corrected for ambient temperature and individual meter deviation

D_G = nearest tabulated dial setting (Col. 1) *greater* than (R)

(2) f_{int} = Δf + Tabular Frequency (Col. 2) corresponding to D_G

where

f_{int} = the interpolated frequency

d. Humidity Correction - Application of the humidity correction ($\Delta f_1\%$) is the last step. Record the ambient relative humidity and temperature, and refer to the Universal Nomograph. Correct the interpolated frequency for the value of $\Delta f_1\%$ obtained from the nomograph by substitution in the following equation:

$$f_c = f_{int}\left[1 + \frac{\Delta f_1}{100}\right]$$

where

$\Delta f_1/100 = \Delta f_1\%$ = value taken from nomograph *(retain sign)*

f_{int} = interpolated frequency (step c)

Here, f_c is the final corrected frequency corresponding to the original observed Cavity Frequency Meter dial setting.

2. Determination of Dial Setting Corresponding to a Given Frequency

The steps outlined in paragraph 1 for the accurate determination of a desired frequency are reversed when the dial setting for a given frequency (f_c) is required.

a. Relative Humidity Consideration - Take the value of $\Delta f_1\%$ for ambient relative humidity from the nomograph. Calculate the interpolated frequency as follows:

(1)
$$f_{int} = \frac{f_c}{1 + \left[\frac{\Delta f_1}{100}\right]}$$

where the notation is the same as in paragraph 1.

b. Interpolation for Corrected Dial Setting (R)

$$\Delta d = \frac{\Delta D}{\Delta F}(f_{int} - f_L)$$

where

Δd = interpolated dial setting increment

ΔD = difference in inches between the nearest pair of tabulated dial setting values (Col. 1) *above* and *below* that corresponding to f_{int}

ΔF = frequency difference (Col. 3) between the nearest pair of tabulated frequency values (Col. 2) *above* and *below* f_{int}

f_{int} = tabular frequency obtained from paragraph 2a

f_L = nearest tabulated frequency *less* than f_{int}

(2) Then

R = (Tabulated dial setting corresponding to f_L) - Δd

c. Correction for Deviation from Standard Calibration Table and Ambient Temperature

(1) $R' = R - d$

where d is obtained from the individual Correction Curve for the instrument and is subtracted from R algebraically.

(2) $D = R' - K$

where K is obtained from the applicable Universal Temperature Correction Chart and is subtracted from R' algebraically.

This will give D, the actual Frequency Meter dial setting, for any given frequency within the range of the particular instrument.

In order to secure maximum accuracy from these Cavity Frequency Meters, it is necessary to apply all the corrections as indicated. However, close approximations to actual frequency can be obtained by the use of the individual frequency deviation Correction Curve only. In the measurement of frequency differences good accuracy will result from consideration of the particular deviation Correction Curve alone since the other corrections applied to the two frequencies will not significantly affect the difference between them.

1. Determination of the Frequency Corresponding to an Observed Dial Setting.

a. Ambient Temperature Correction - Note the dial setting (D) of the Frequency Meter at resonance. Refer to the applicable Universal Temperature Correction Chart in which the correction (K) is plotted as a function of ambient temperature for various values of D. For values of D not plotted on the chart, obtain the value of K by interpolating either arithmetically or visually, making some allowance for the fact that K is not linear in D, but cubic. Add the value of K algebraically to the initial dial reading to obtain the corrected dial reading (R'):

$$R' = D + K$$

b. Correction for Deviation from Standard Calibration - Refer to the Correction Curve for the particular instrument. The observed dial reading lies along the X axis. Obtain the correction (d) from the Correction Curve using the actual or observed dial reading. Add the correction (d) algebraically to the dial setting, or, if the correction is to be applied to the answer obtained in step a, add the correction algebraically to that answer to obtain a corrected dial reading (R), combining both corrections:

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where

$\Delta f_1/100 = \Delta f_1\%$ = value taken from nomograph *(retain sign)*

f_{int} = interpolated frequency (step c)

Here, f_c is the final corrected frequency corresponding to the original observed Cavity Frequency Meter dial setting.

2. Determination of Dial Setting Corresponding to a Given Frequency

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$$\Delta d = \frac{\Delta D}{\Delta F}(f_{int} - f_L)$$

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ΔF = frequency difference (Col. 3) between the nearest pair of tabulated frequency values (Col. 2) *above* and *below* f_{int}

f_{int} = tabular frequency obtained from paragraph 2a

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This will give D, the actual Frequency Meter dial setting, for any given frequency within the range of the particular instrument.

In order to secure maximum accuracy from these Cavity Frequency Meters, it is necessary to apply all the corrections as indicated. However, close approximations to actual frequency can be obtained by the use of the individual frequency deviation Correction Curve only. In the measurement of frequency differences good accuracy will result from consideration of the particular deviation Correction Curve alone since the other corrections applied to the two frequencies will not significantly affect the difference between them.

Publication SJ-26-0034G
June 1960

STANDARD CALIBRATION TABLE[1]
FOR
SPERRY Microline[2] CAVITY FREQUENCY METER
MODEL 14C1

Serial No._____

4010 - 6000 Mc[3]

1 Dial Setting (Inches)	2 Frequency (Mc)	3 Frequency Difference (Mc)	1 Dial Setting (Inches)	2 Frequency (Mc)	3 Frequency Difference (Mc)
0.05000	6029.8		0.30000	5249.2	25.1
0.06	5991.1	38.7	0.31	5224.5	24.7
0.07	5953.3	37.8	0.32	5200.3	24.2
0.08	5916.2	37.1	0.33	5176.5	23.8
0.09	5879.8	36.4	0.34	5153.1	23.4
			0.35	5130.1	23.0
0.10000	5844.0	35.8	0.36	5107.5	22.6
0.11	5808.9	35.1	0.37	5085.2	22.3
0.12	5774.4	34.5	0.38	5063.2	22.0
0.13	5740.5	33.9	0.39	5041.5	21.7
0.14	5707.3	33.2			
0.15	5674.7	32.6	0.40000	5020.1	21.4
0.16	5642.8	31.9	0.41	4999.1	21.0
0.17	5611.4	31.4	0.42	4978.5	20.6
0.18	5580.4	31.0	0.43	4958.3	20.2
0.19	5550.1	30.3	0.44	4938.4	19.9
			0.45	4918.8	19.6
0.20000	5520.3	29.8	0.46	4899.4	19.4
0.21	5491.0	29.3	0.47	4880.2	19.2
0.22	5462.2	28.8	0.48	4861.3	18.9
0.23	5433.9	28.3	0.49	4842.6	18.7
0.24	5406.2	27.7			
0.25	5379.0	27.2	0.50000	4824.3	18.3
0.26	5352.2	26.8	0.51	4806.3	18.0
0.27	5325.8	26.4	0.52	4788.6	17.7
0.28	5299.8	26.0	0.53	4771.3	17.3
0.29	5274.3	25.5	0.54	4754.3	17.0

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[1] This Calibration Table applicable to any Model 14C1 Frequency Meter.

[2] Reg. U.S. Pat. Off.

[3] Tabular entries above and below the specified operating range are for reference only.

1 Dial Setting (Inches)	2 Frequency (Mc)	3 Frequency Difference (Mc)
.54	4754.3	
.55	4737.4	16.9
.56	4720.7	16.7
.57	4704.2	16.5
.58	4687.9	16.3
0.59	4671.8	16.1
0.60000	4656.0	15.8
0.61	4640.5	15.5
0.62	4625.2	15.3
0.63	4610.1	15.1
0.64	4595.2	14.9
0.65	4580.5	14.7
0.66	4566.0	14.5
0.67	4551.7	14.3
0.68	4537.6	14.1
0.69	4523.7	13.9
0.70000	4510.0	13.7
0.71	4496.5	13.5
0.72	4483.4	13.3
0.73	4470.5	13.1
0.74	4457.2	12.9
0.75	4444.5	12.7
0.76	4431.9	12.6
0.77	4419.4	12.5
0.78	4407.1	12.3
0.79	4395.0	12.1
0.80000	4383.0	12.0
0.81	4371.2	11.8
0.82	4359.5	11.7
0.83	4348.0	11.5
0.84	4336.6	11.4
0.85	4325.4	11.2
0.86	4314.3	11.1
0.87	4303.4	10.9
0.88	4292.6	10.8
0.89	4282.0	10.6
0.90000	4271.5	10.5
0.91	4261.1	10.4
0.92	4250.9	10.2
0.93	4240.8	10.1
0.94	4230.8	10.0
0.95	4220.9	9.9
0.96	4211.2	9.7
0.97	4201.6	9.6
0.98	4192.1	9.5
0.99	4182.7	9.4
1.00000	4173.4	9.3
1.01	4164.2	9.2
1.02	4155.1	9.1
1.03	4146.1	9.0
1.04	4137.2	8.9
1.05	4128.4	8.8
1.06	4119.7	8.7
1.07	4111.1	8.6
1.08	4102.6	8.5
1.09	4094.3	8.3
1.10000	4086.1	8.2
1.11	4078.0	8.1
1.12	4070.0	8.0
1.13	4062.1	7.9
1.14	4054.2	7.9
1.15	4046.4	7.8
1.16	4038.7	7.7
1.17	4031.1	7.6
1.18	4023.6	7.5
1.19	4016.2	7.4
1.20	4008.9	7.3

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MODEL 14C1

Serial No. _____

4010 - 6000 Mc[3]

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0.06	5991.1	38.7	0.31	5224.5	24.7
0.07	5953.3	37.8	0.32	5200.3	24.2
0.08	5916.2	37.1	0.33	5176.5	23.8
0.09	5879.8	36.4	0.34	5153.1	23.4
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0.12	5774.4	34.5	0.38	5063.2	22.0
0.13	5740.5	33.9	0.39	5041.5	21.7
0.14	5707.3	33.2			
0.15	5674.7	32.6	0.40000	5020.1	21.4
0.16	5642.8	31.9	0.41	4999.1	21.0
0.17	5611.4	31.4	0.42	4978.5	20.6
0.18	5580.4	31.0	0.43	4958.3	20.2
0.19	5550.1	30.3	0.44	4938.4	19.9
			0.45	4918.8	19.6
0.20000	5520.3	29.8	0.46	4899.4	19.4
0.21	5491.0	29.3	0.47	4880.2	19.2
0.22	5462.2	28.8	0.48	4861.3	18.9
0.23	5433.9	28.3	0.49	4842.6	18.7
0.24	5406.2	27.7			
0.25	5379.0	27.2	0.50000	4824.3	18.3
0.26	5352.2	26.8	0.51	4806.3	18.0
0.27	5325.8	26.4	0.52	4788.6	17.7
0.28	5299.8	26.0	0.53	4771.3	17.3
0.29	5274.3	25.5	0.54	4754.3	17.0

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Model 14C1 Frequency Meter, Serial No.

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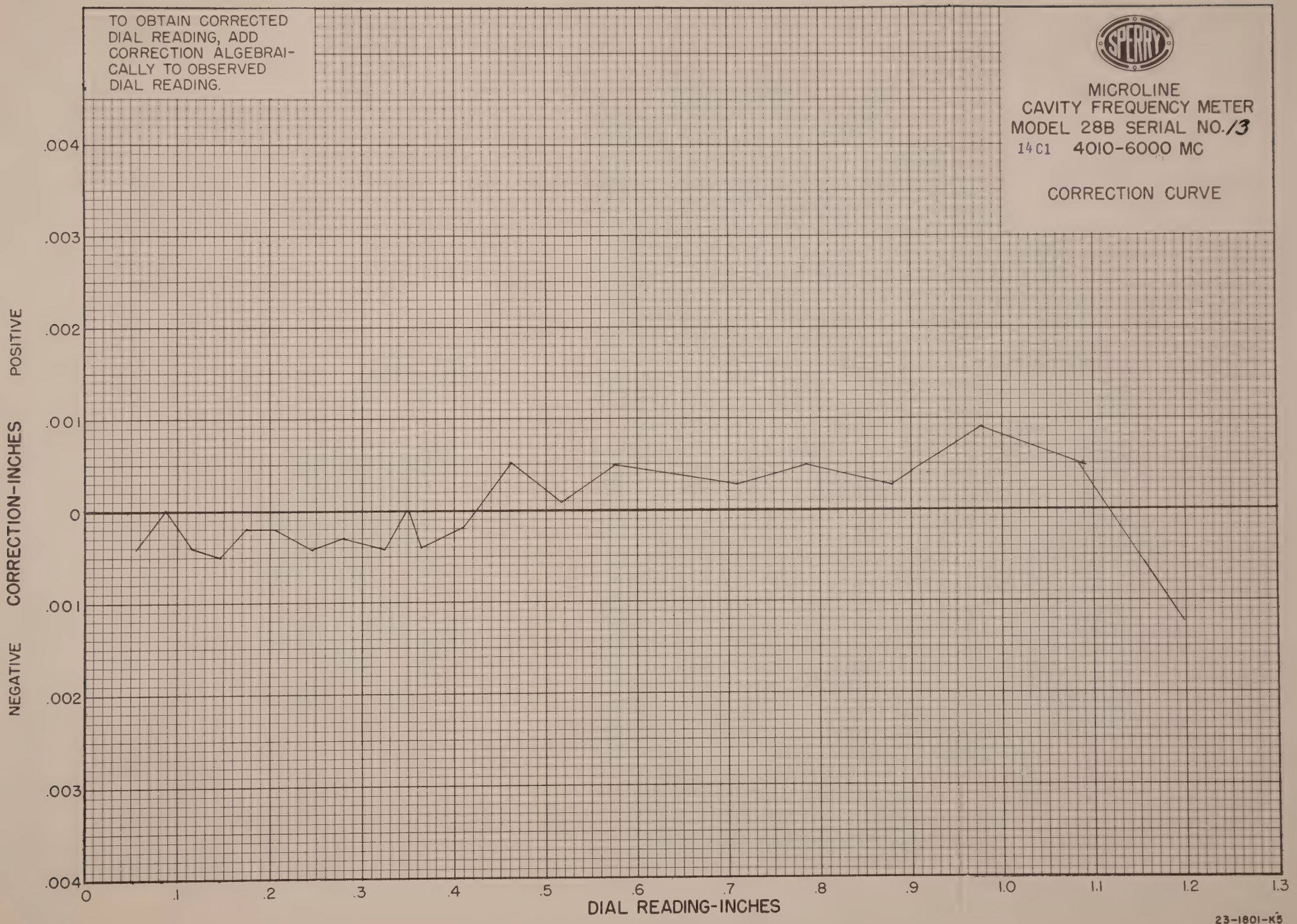
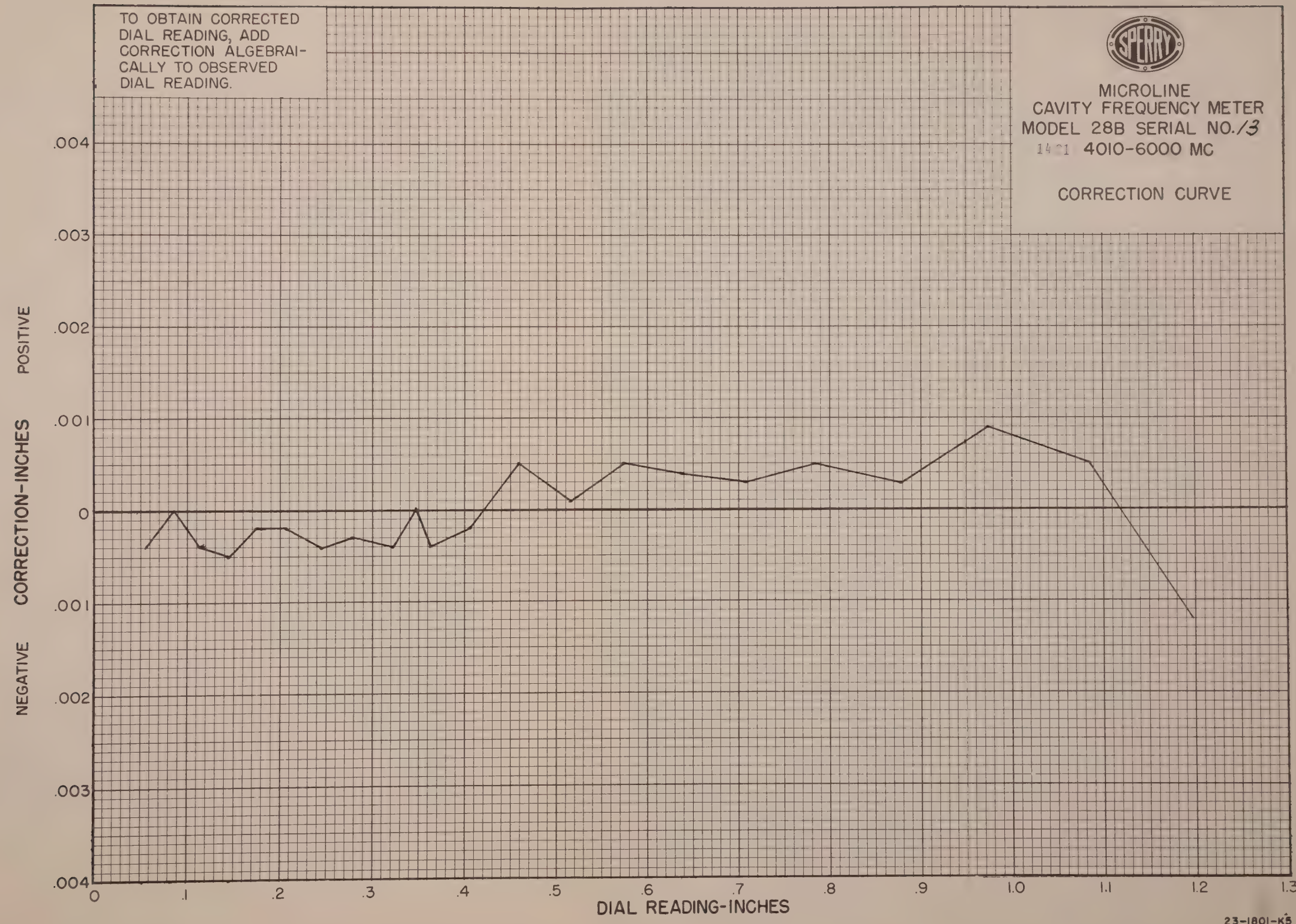
.54	4754.3	
.55	4737.4	16.9
.56	4720.7	16.7
0.57	4704.2	16.5
0.58	4687.9	16.3
0.59	4671.8	16.1
0.60000	4656.0	15.8
.61	4640.5	15.5
.62	4625.2	15.3
0.63	4610.1	15.1
0.64	4595.2	14.9
0.65	4580.5	14.7
.66	4566.0	14.5
.67	4551.7	14.3
.68	4537.6	14.1
0.69	4523.7	13.9
0.70000	4510.0	13.7
0.71	4496.5	13.5
0.72	4483.4	13.3
0.73	4470.5	13.1
0.74	4457.2	12.9
0.75	4444.5	12.7
0.76	4431.9	12.6
0.77	4419.4	12.5
0.78	4407.1	12.3
0.79	4395.0	12.1
0.80000	4383.0	12.0
0.81	4371.2	11.8
0.82	4359.5	11.7
0.83	4348.0	11.5
0.84	4336.6	11.4
0.85	4325.4	11.2
0.86	4314.3	11.1
0.87	4303.4	10.9
0.88	4292.6	10.8
0.89	4282.0	10.6
0.90000	4271.5	10.5
0.91	4261.1	10.4
0.92	4250.9	10.2
0.93	4240.8	10.1
0.94	4230.8	10.0
0.95	4220.9	9.9
0.96	4211.2	9.7
0.97	4201.6	9.6
0.98	4192.1	9.5
0.99	4182.7	9.4
1.00000	4173.4	9.3
1.01	4164.2	9.2
1.02	4155.1	9.1
1.03	4146.1	9.0
1.04	4137.2	8.9
1.05	4128.4	8.8
1.06	4119.7	8.7
1.07	4111.1	8.6
1.08	4102.6	8.5
1.09	4094.3	8.3
1.10000	4086.1	8.2
1.11	4078.0	8.1
1.12	4070.0	8.0
1.13	4062.1	7.9
1.14	4054.2	7.9
1.15	4046.4	7.8
1.16	4038.7	7.7
1.17	4031.1	7.6
1.18	4023.6	7.5
1.19	4016.2	7.4
1.20	4008.9	7.3


TO OBTAIN CORRECTED DIAL READING, ADD CORRECTION ALGEBRAICALLY TO OBSERVED DIAL READING.
SPERRY
MICROLINE
CAVITY FREQUENCY METER
MODEL 28B SERIAL NO. 13
14C1 4010-6000 MC
CORRECTION CURVE
NEGATIVE CORRECTION-INCHES POSITIVE
.004
.003
.002
.001
0
.001
.002
.003
.004
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
1.1
1.2
1.3
DIAL READING-INCHES
23-1801-K5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MODEL 28B SERIAL NO. 13
1401 4010-6000 MC
CORRECTION CURVE
NEGATIVE CORRECTION-INCHES POSITIVE
.004
.003
.002
.001
0
.001
.002
.003
.004
0
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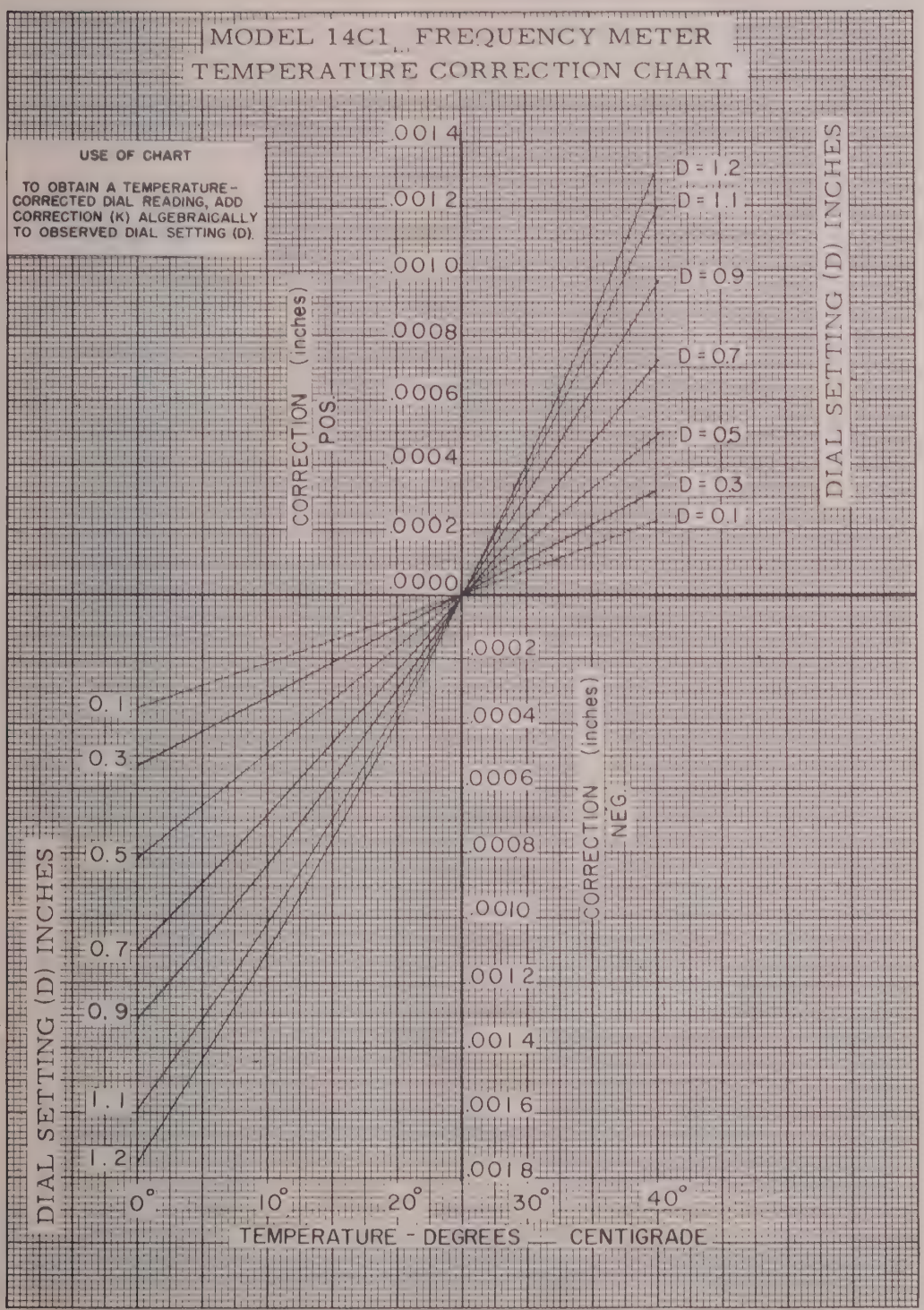
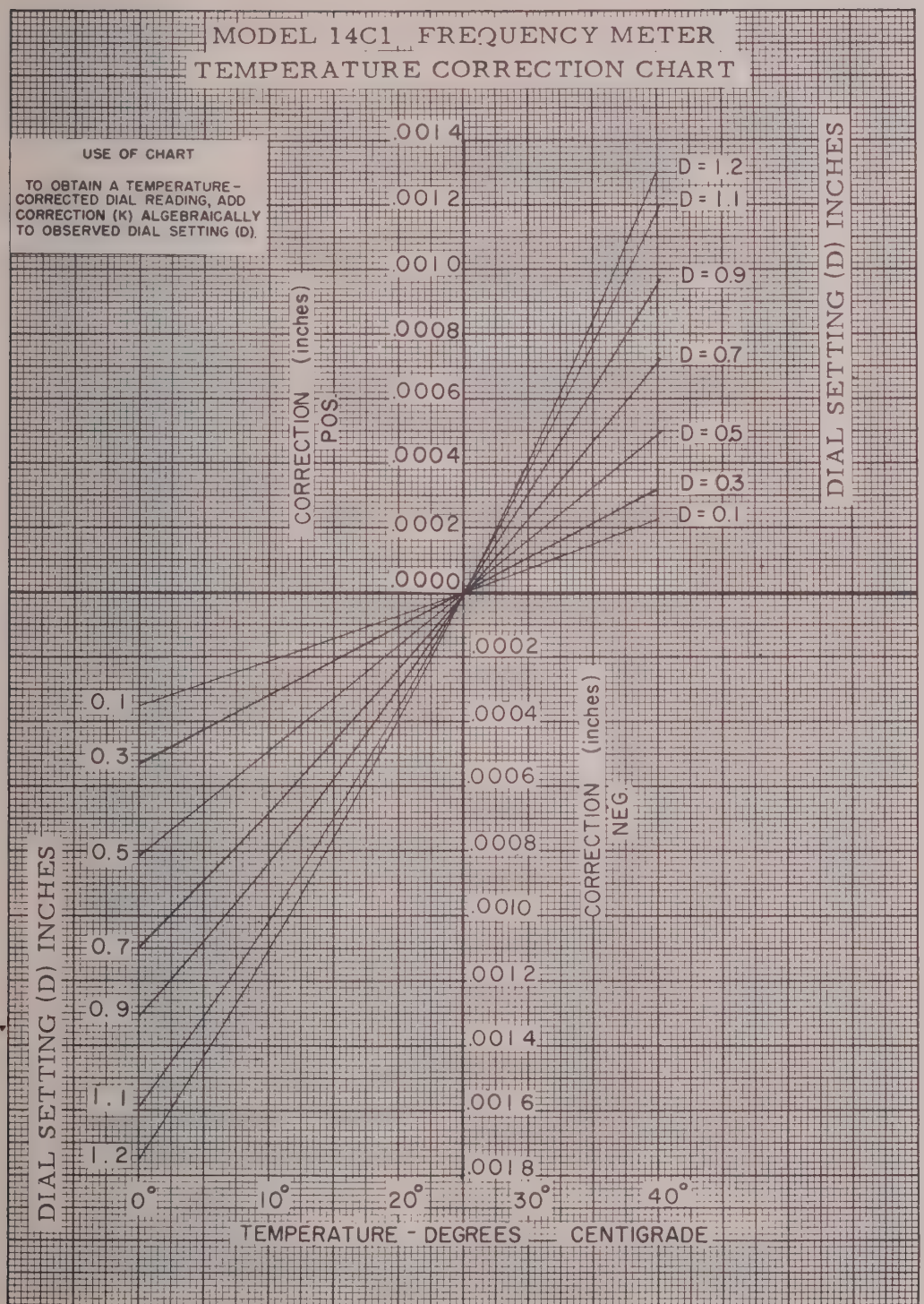
DIAL READING-INCHES
23-1801-K5



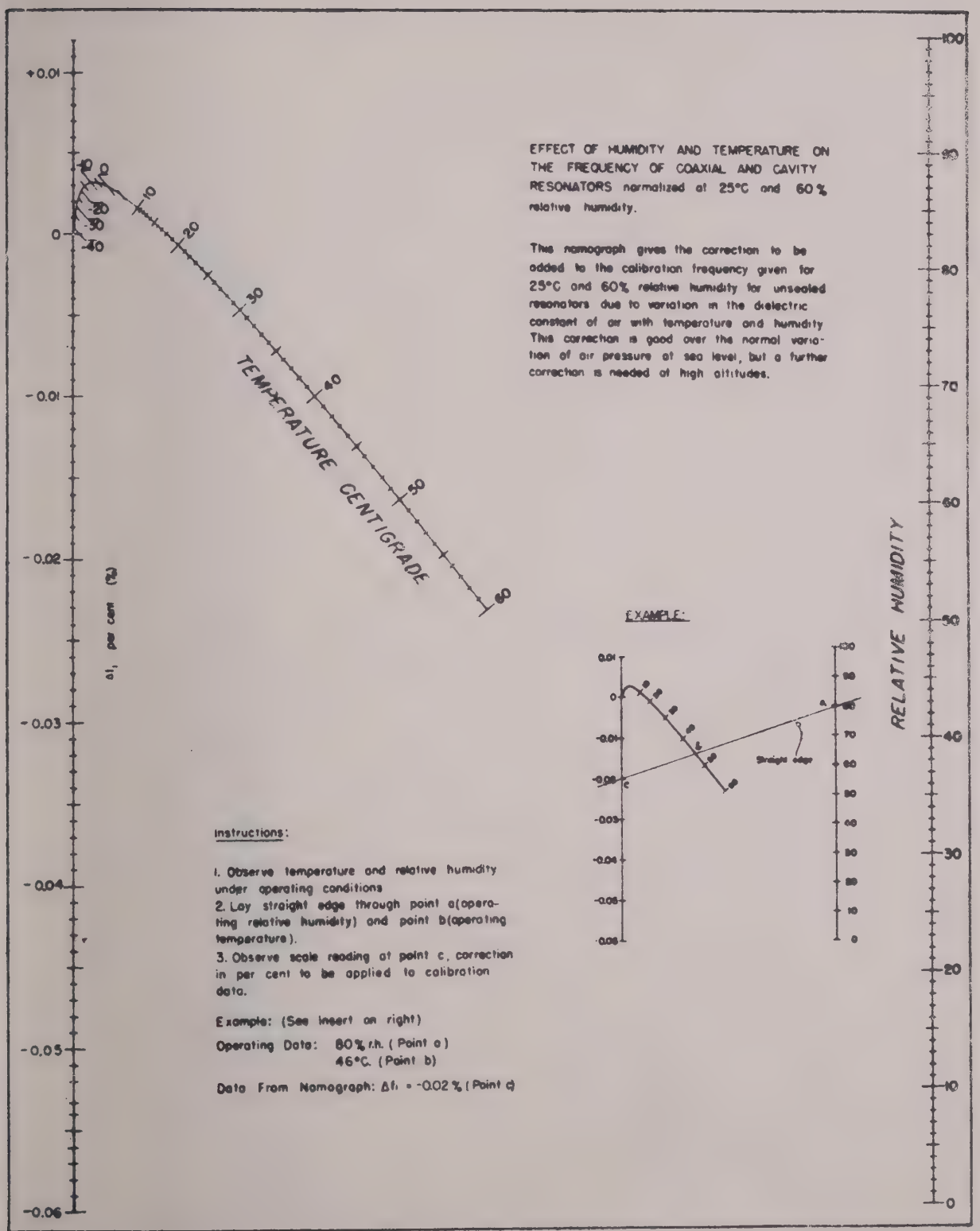
Publication No. SJ-26-0034C



Publication No. SJ-26-0034C

EFFECT OF HUMIDITY AND TEMPERATURE ON THE FREQUENCY OF COAXIAL AND CAVITY RESONATORS normalized at 25°C and 60% relative humidity.

This nomograph gives the correction to be added to the calibration frequency given for 25°C and 60% relative humidity for unsealed resonators due to variation in the dielectric constant of air with temperature and humidity. This correction is good over the normal variation of air pressure at sea level, but a further correction is needed at high altitudes.



EXAMPLE:

Instructions:

1. Observe temperature and relative humidity under operating conditions
2. Lay straight edge through point a(operating relative humidity) and point b(operating temperature).
3. Observe scale reading at point c, correction in per cent to be applied to calibration data.

Example: (See insert on right)

Operating Data: 80% r.h. (Point a)
46°C. (Point b)

Data From Nomograph: $\Delta f_i = -0.02\%$ (Point c)

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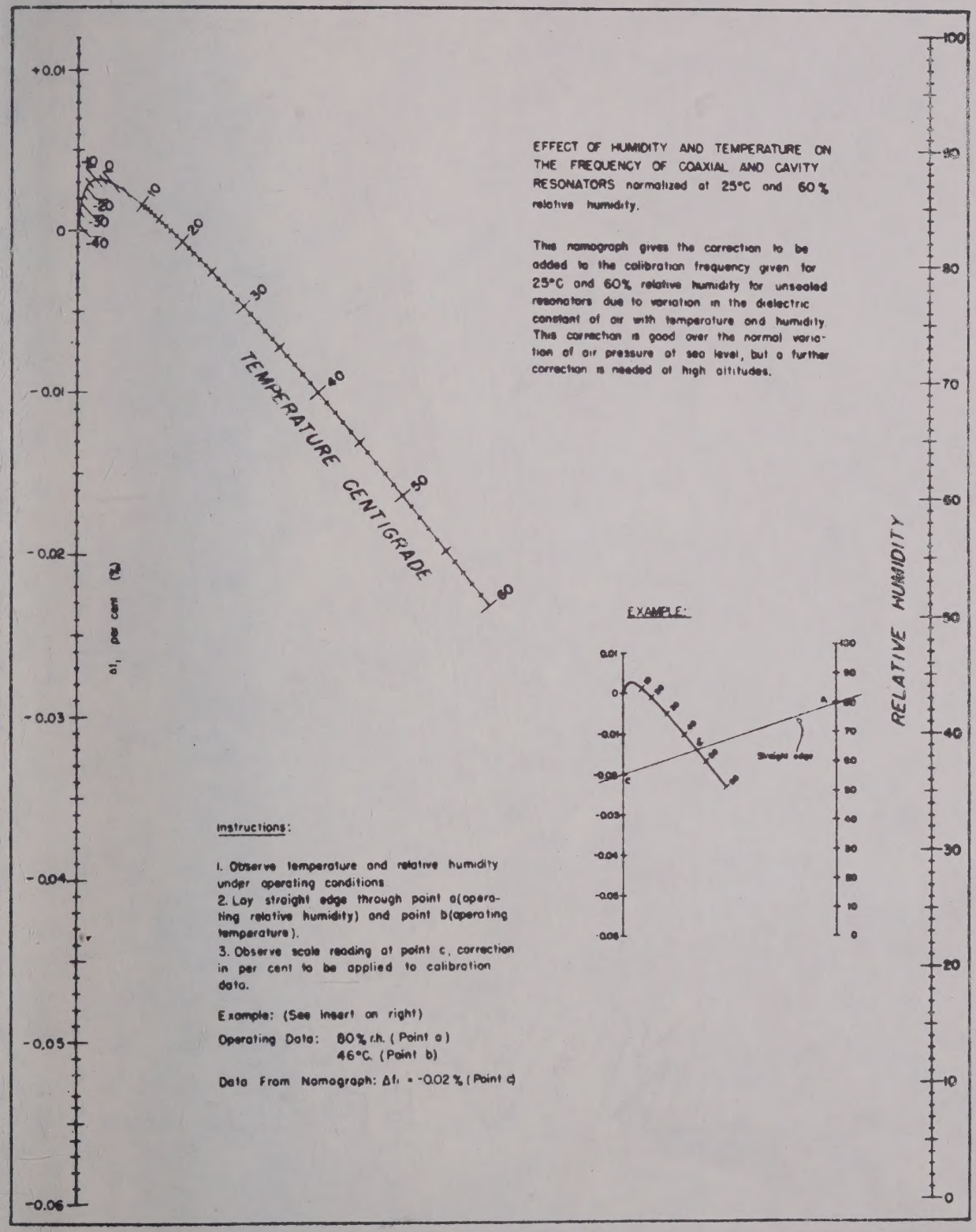

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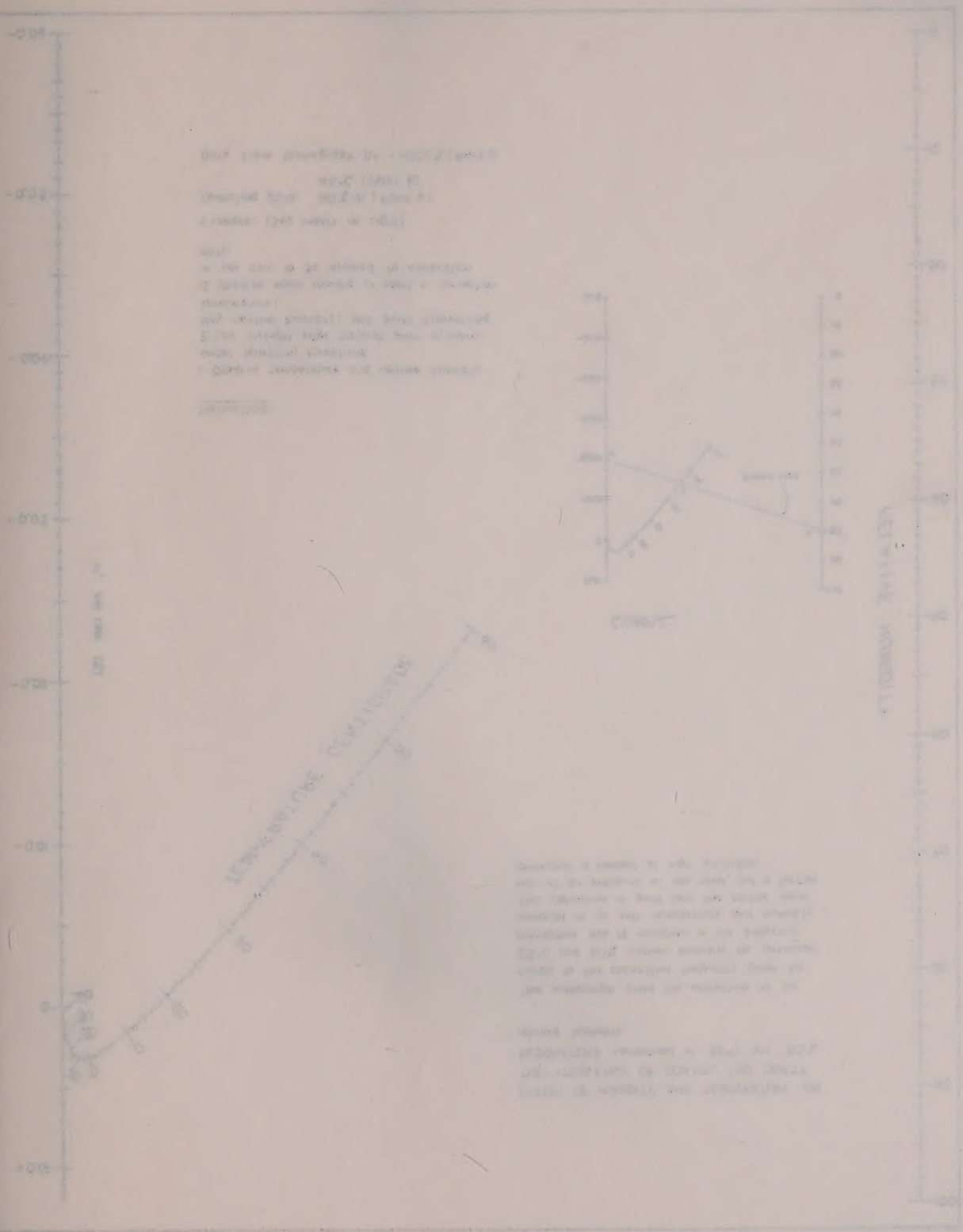

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